GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF RESEARCH ADMINISTRATION

RESEARCH PROJECT INITIATION

Date: August 27, 1974

Project Title: Environmental Health Engineering & Science

Project No: E-20-530

Principal Investigator: Dr. M. A. McClanahan

Sponsor: Division of Associated Health Professions, PHS

Agreement Period: From July 1, 1974 Until June 30, 1975

Type Agreement: Training Grant No. 1 A04 AH00712-01

Amount: $23,052

Reports Required: Final Report due by October 31, 1975

Sponsor Contact Person (s):

W. S. Brooks, Chief
Program Operating Branch
Division of Allied Health Manpower, DHEW
Bethesda, Maryland 20014

Note: Continuation of E-20-522

Assigned to: Civil Engineering

COPIES TO:

Principal Investigator	Library
School Director	Rich Electronic Computer Center
Dean of the College	Photographic Laboratory
Director, Research Administration	Project File
Director, Financial Affairs (2)	
Security-Reports-Property Office	
Patent Coordinator	Other

RA-3 (6-71)

AUG 1974
RECEIVED
Research Security
Office

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Posted 6/15

Date: July 11, 1977

Project Title: Environmental Health Engineering and Science.

Project No: E-20-530

Project Director: Dr. A. W. Hoadley

Sponsor: Public Health Service, Division of Associated Health Professions

Effective Termination Date: 6/30/76

Clearance of Accounting Charges: 6/30/76

Grant/Contract Closeout Actions Remaining:

_ Final Invoice and Closing Documents
x Final Fiscal Report (Report of Expenditures)
x Final Report of Inventions
_ Govt. Property Inventory & Related Certificate
_ Classified Material Certificate
_ Other _____

Assigned to: Civil Engineering (School/Laboratory)

COPIES TO:

Project Director
Division Chief (EES)
School/Laboratory Director
Dean/Director—EES
Accounting Office
Procurement Office
Security Coordinator (OCA)
Reports Coordinator (OCA)
Library, Technical Reports Section
Office of Computing Services
Director, Physical Plant
EES Information Office
Project File (OCA)
Project Code (GTRI)
Other _____

CA—4 (3/76)

E-20-330

FINAL PROGRESS REPORT

I. INTRODUCTION

A. Grant No.: 1 A04 AH00712-01

Title: Environmental Health Engineering and Science Training

B. Grantee Institution: Georgia Institute of Technology

C. Program Director: Alfred W. Hoadley, Ph.D.

D. Report Period: 7/1/74-6/30/76

E. Date: June, 1977

II. TRAINEES SUPPORTED AND PROGRAM DEVELOPMENTS

A. The purpose of this graduate training program is to prepare engineers and scientists for professional work and services in the general field of environmental health engineering and environmental quality protection. Students who successfully complete the training program will have a sufficiently broad background of training to function effectively in the broad environmental health field, yet may also have completed a limited amount of more advanced study in a particular interest area such as water supply and water treatment, solid waste management, radiological health or air pollution control. Graduates of the training program are well prepared, in particular, to assume appropriate positions of responsibility in health agencies at the local, state and federal level, and to work across specialty area boundaries as well as within a particular area of interest. Such individuals are considered to be especially well suited for positions of relatively broad program responsibility, and will be able to work toward administrative and management positions of major environmental health program responsibility. The principal emphasis in the graduate training program is at the M.S. level, in order to train individuals prepared to meet the immediate need in environmental health engineering and science. This program of graduate training is concerned with the various aspects of environmental health engineering and environmental quality protection, as distinct from personal or individual health protection programs such as health physics and medical physics.

B. During the report period, there have been changes in faculty, and, we feel, a general strengthening of the program in Environmental Engineering.

During this period, Dr. Tsivoglou, Dr. Kornegay, Mr. Wiscovitch have resigned. Additions to the faculty include:

Wendall Cross, Ph.D. Chemist. Teaches in environmental chemistry courses and labs. General responsibilities for maintenance and operation of environmental engineering laboratories.

Joseph P. Gould, Ph.D. Aquatic Chemist. Teaches environmental chemistry and undergraduate courses.

F. Michael Saunders, Ph.D. Environmental Engineer. Teaches environmental processes and operations and undergraduate courses.

Makram T. Suidan, Ph.D. Environmental Engineer. Teaches new physical principles, stream analysis, industrial wastes and undergraduate courses.

Resumes of new faculty are attached.

Changes in faculty have lead to a general reexamination of the program in Environmental Engineering and coordination of courses. Specialized seminars have been instituted and student participation in them has been active. A new course has been instituted dealing with physical principles which permits better coverage of recent techniques in the processes, operations, and industrial wastes courses.

C. During the period July 1, 1974 through June 30, 1976, the following students were supported with the aid of this grant:

Beverly Kush, environmental sciences. Supported for 5 full quarters and 1 partial quarter. Present status: employed in EPA laboratory evaluation program in the State of Ohio. This student undertook research on bacterial quality in whirlpool baths, and is occupied in an environmental health related position.

Thomas D. Enyeart, nuclear engineering. Supported 5 quarters. Present status: He has completed all but the final review phases of his M. S. research and is now working for the Westinghouse Nuclear Facility in Idaho Falls, Idaho. He is concerned with treatment and disposal of liquid nuclear wastes. His research was on the forms of cadmium found in sewage sludge with reference to the potential heavy metal build-up resulting from the land application of sludges.

Sandra Enyeart, civil engineering. Supported for 3 quarters. Present status: housewife. This was an outstanding student who, in spite of strong interests in environmental health and in her career, has made a difficult decision to follow the wishes of her husband and give up her career.

Michael A. Rollor, biology. Supported for 5 quarters. Present status: student. Mr. Rollor has a strong interest in environmental health and plans to continue graduate school in public health. Mr. Rollor's graduate research is on mutagenicity testing of chlorinated compounds in wastes.

Jack S. Cook, Jr., biology. Supported for 4 quarters. Present status: student. Mr. Cook is an extremely capable student who expects to finish his master's level studies in December, 1977. His plans for the future are not settled, but I believe he will work for several years and return to graduate school. His graduate research is on R factors in environmental Pseudomonas strains.

D. The results of the training program supported by this grant must be judged in terms of the interests and activities of the graduate program and in terms of what the faculty view as the objectives of the program.

It must be admitted that while many students receiving support under this program have a genuine interest in environmental health, the very strong emphasis on treatment processes within the program makes the study of environmental health problems difficult for these students, and most do not work in the field of environmental health after graduating. They do work in environmental health engineering, and most have a strong background and interest in environmental quality. I think that it must be admitted, furthermore, that the students demonstrating the strongest interest in environmental health per se have backgrounds in the sciences, particularly biology. We would like to see more engineers pursuing interests more directly concerned with environmental health. Very few engineers not supported by traineeships under this grant have elected to undertake research directly related to environmental health.

I think the traineeship program should be viewed as a success in the sense that it has encouraged and provided support for students from engineering and the sciences in the pursuit of graduate training in environmental health engineering and science. I think it should be viewed as a success, furthermore, in the sense that these students have received the training they sought and they are, for the most part, making use of that training. The existing program in the treatment of water and wastes is a strong one. I believe, however, that if environmental health is to be part of the program, training opportunities must be strengthened substantially. I believe the interaction of environmental health engineering students with students in related environmental health sciences should be strengthened.

Health related research in the Environmental Engineering Program at Georgia Tech in the past has been concerned with bacterial pathogens and their indicators, ear infections in relation to bathing water quality, transferable drug resistance, and disinfection. These exist strong interests and capabilities among the faculty in chemical carcinogens, teratogens, mutagens, viruses, and the environmental health aspects of development in emerging nations. Serious and immediate consideration should be given to our

potential roles in this area. An effort should be made through visits to the National Institute of Environmental Health Sciences and the Health Effects Branch of the EPA to determine their needs and their views concerning training needs. Consideration should be given to interest in training both engineers, providing them with biological, chemical, and environmental background, and biologists and chemists, providing them with engineering-related as well as futher environmental and applied training in their fields of specialization. A program in this area should be developed in conjunction with the School of Biology.

Existing courses at Georgia Tech can support training programs in environmental health. If environmental health is to be developed further at Georgia Tech, and students and funding for student support sought, courses must be available in the following areas:

A. Basic Sciences
   1. Chemistry
   2. Biology
   3. Physics

B. Applied Sciences and Engineering
   1. Analysis of Environmental Pollutants
   2. Sources and Control of Environmental Pollutants
   3. Behavior Effects, and Fate of Pollutants in the Environment

Course requirements might include minimum credit requirements in each category. Representative courses available at Georgia Tech are listed in the Attachments. We would anticipate that a Master's program in Environmental Health and the Health Effects of Environmental Pollutants would require 2 years and the satisfactory completion of a thesis. Programs in these areas can be built upon strengths existing at Georgia Tech and would not entail development of new program areas. They also would have to be developed in close collaboration with the Schools of Biology and Chemistry and in consultation with Federal Funding agencies.

ATTACHMENT
Courses Relating to Health
Effects of Environmental Pollutants

A. Basic Sciences

1. Chemistry

Chem. 3311-2-3	Organic Chemistry	3-0-3
Chem. 3381-2	Organic Chemistry Lab	0-6-2
Chem. 3385	Organic Chemistry Lab	0-12-4
Chem. 3411-2-3	Physical Chemistry	3-0-3
Chem. 3481	Physical Chemistry Lab	0-6-2
Chem. 3491	Physical Chemistry Lab	0-6-2
Chem. 3511	Biochemistry	3-0-3
Chem. 3541	Biophysical Chemistry	3-0-3
Chem. 4511-2	Biochemistry	3-0-3
Chem. 4581	Biochemistry Laboratory	0-6-2

2. Biology

Biol. 3310	Gen. Microbiology	3-6-5
Biol. 3320	Cell Physiology	3-3-4
Biol. 3333	Biostatistics	3-3-4
Biol. 3334	Genetics	3-3-4
Biol. 3711	Anatomy and Physiology	3-0-3
Biol. 4407	Adv. Microbiology	3-4-4
Biol. 4408	Microbial Genetics	3-6-5
Biol. 4409	Microbial Physiology	3-6-5
Biol. 4443	Gen. Animal Physiol. I	3-6-5
Biol. 4444	Gen. Animal Physiol. II	3-6-5
Biol. 4466	Genetics of Populations	3-0-3
Biol. 4468	Mol. Genetics	3-3-4
Biol. 4470	Biophys. Genetics	3-0-3
Biol. 6633	Sel. Topics in Radiobiol.	3-3-4
Biol. 6646	Mammalian Physiol.	3-3-4
Biol. 6647	Developmental Physiol.	3-6-5
Biol. 6664	Sel. Top. in Reg. Biol.	3-0-3
Biol. 6711	Medical Physiology	5-0-5

3. Physics

Phys. 3251	Biophysics I	3-0-3
Phys. 3253	Biophysics II	3-3-4

B. Applied Science and Engineering

1. Analysis of Environmental Pollutants

Chem. 4211	Instrumental Analysis I	3-6-5
Chem. 4212	Instrumental Analysis II	3-6-5

Chem. 4341	Applied Spectroscopy	3-0-3
Chem. 5201	Anal. of Atmos. Contaminants	3-0-3
Chem. 6211-2	Analytical Chemistry	3-0-3
Chem. 6221	Ors. Reagents in Anal. Chem.	3-0-3
Chem. 6230	Electrochemistry	3-0-3
Chem. 6231	Electroanalytical Chem.	3-0-3
Chem. 6241	Adv. Anal. Chem.	3-0-3
Chem. 6342	Inst. Meth. in Org. Anal.	3-0-3
Chem. 6351	Organomet. Chem.	3-0-3
Biol. 6640	Inst. Meth. in Biol.	3-6-5
Biol. 6641	Elect. Microsc. Lab	0-6-2
C.E. 6108	Appl. of Inst. Anal. in S.E.	2-3-3
N.E. 4630	Isotopic Tracer Methodol.	2-3-3
N.E. 6110	Radiation Detection I	2-6-4
N.E. 6111	Adv. Radiation Detect.	3-0-3

2. Sources and Control of Environmental Pollutants

C.E. 4103	San. Eng'g I	3-0-3
C.E. 4113	San. Eng'g II	3-0-3
C.E. 4133	Eng'g Aspects of Environ. Hlth.	3-0-3
C.E. 4143	Man in His Environment	3-0-3
C.E. 6113	Ind. Waste Treat. and Dispos.	2-3-3
C.E. 6139	Appl. of Chem. in San. Eng'g	3-3-4
C.E.	Phys. Proc. in San Eng'g	3-0-3
C.E. 6144	San. Eng'g Processes I	3-3-4
C.E. 6149	San. Eng'g Processes II	3-3-4
Ch.E. 6611	Ind. Emission Control	3-0-3
Biol. 3316	Indust. Hyg.	3-0-3
N.E. 4620	Nucl. Technol. and the Environ.	3-0-3
N.E. 6430	Rad. Prot. in Nuclear Fac.	3-0-3
N.E. 6641	Env. Surv. and Rad. Waste Disp.	3-0-3
N.E. 6783	(Same as 6641 but with lab)	3-3-4

3. Behavior and Effects of Pollutants in the Environment

Biol. 4412	Intro. Aerobiology	3-0-3
Biol. 6730	Biol. Effect of Rad.	3-3-4
C.E. 6123	Stream Analysis	3-0-3
C.E. 6103	Aquatic Chemistry	3-0-3
C.E. 4774	Appl. of Micro. in S.E.	3-3-4
Geol. 4600	Intro. to Geochemistry	3-3-4
Geol. 6600	Aqueous Geochemistry	3-0-3
Geol. 6610	Organic Geochemistry	3-0-3
Ch.E. 6610	Aerosol Technology	3-0-3
Ch.E. 6612	Atmospheric Reactions	3-0-3
Ch.E. 6613	Tech. of Fine Particles	3-0-3
N.E. 4412	Princ. of Health Physics	3-0-3
N.E. 4413	Appl. Health Physics	3-3-4
N.E. 4440	Effects of Non-Ion. Rad. & Proc. Stds.	3-0-3
N.E. 6401	Rad. Health Phys.	3-0-3
N.E. 6405	Health Phys. Practice	1-6-3

N.E. 6410	Rad. Dosimetry	3-0-3
N.E. 6411	Appl. Rad. Phys.	2-3-3
N.E. 6412	Rad. Dosimetry Systems	1-6-3
N.E. 6442	Appl. Hlth. Phys. Lab.	1-6-3

[Could be put into C.E. 4133 - Epidemiology, Toxicology, Environ. Aspects of Environ. Toxicants]

[Behavior and Fate of Organic Compounds in the Aquatic Environ.]

RESUMÉ

Wendall H. Cross
Research Scientist, Chemist

Business Address:

Sanitary Engineering Department
Georgia Institute of Technology
Atlanta, Georgia 30332

Telephone:

(404) 894-2265

Home Address:

3981 Donegal Court
Tucker, Georgia 30084

Telephone:

(404) 938-4067

EDUCATION

B.S.	Chemistry	1960	Montana State University
M.S.	Chemistry Major: Analytical Minor: Organic	1962	South Dakota School of Mines and Technology
Ph.D.	Chemistry Major: Inorganic Minor: Physical	1967	Georgia Institute of Technology

Teaching Related Activities

Director of all laboratory operations in Environmental Engineering.
Include: a) ordering all supplies, chemicals and equipment
b) supervising laboratory preparation
c) maintenance and repair of all instrumentation
d) special instruction in analytical techniques and methods for specific analyses

Designed and had remodeled the physical facilities for a new instrumental analysis laboratory in Daniel Laboratory. Determined best floor plant utilizing the available space and laboratory furniture left over from the old CE building to create a larger more efficient instrumentation laboratory which allows the department to make better use of both the instrumentation and limited laboratory space available.

Safety Director for Daniel Laboratory Building.

Sanitary Engineering ad hoc Committee to review and reorganize Sanitary Engineering I and II (CE 4103/4113), 1975-1976

Special Task Force to Develop Goals for Sanitary Engineering, Georgia Tech (1975-present)

Special Activities

Lecturer on "Applied Analytical Chemistry in Sanitary Engineering"
Presented to: Civil Engineering Freshmen, Summer 1976
Chemistry Sophomores, Kennesaw Jr. College, Summer 1976
Randolph-Macon College, Chemistry Majors, Spring 1977

Scholarship and Creativity

Theses

1. M. S. South Dakota School of Mines and Technology
"Reactions of the 3-Methyl-1,2,4-Triazole-5-Thiol Copper (II) System"

2. Ph.D. Georgia Institute of Technology
"Complexes of Cobalt (III) with Trans-1,2-Cyclopentanediamine"

Administrative Duties and Responsibilities

1966-1968
(Morehead State University)

Head, Chemistry Department
Class Scheduling, Purchasing, Budget Preparation, Hiring and Evaluation of Personnel, Program Development, Research

1968-71
(Atlanta Baptist College)
Admitted first students 1968

Chairman, Division of Sciences and Mathematics
Supervision of development of science programs, Hiring and evaluation of personnel, Budget preparation, Purchasing, Class scheduling

1971-75
(Georgia State University)

Administrative Assistant, Chemistry Department
Coordination and operation of all chemistry laboratories including:

a) Hiring, training and supervision of all laboratory personnel (two laboratory technicians, stockroom manager, secretary, six to eight graduate assistants and four to six undergraduate assistants per quarter)
b) Supervision of all departmental and research grant purchasing
c) Maintainance of all laboratory and research instrumentation
d) Course scheduling
e) Supervision of the preparation, standardization and distribution of all laboratory chemicals

University and Committee Service

Member, American Chemical Society, 1958-present
Member, Georgia Section ACS, 1968-present
Member, Society of the Sigma Xi, 1966-present
Member, Standard Methods Joint Task Group on Tests on Volatile Acids, 1975-present
Co-Chairman, Standard Methods Joint Task Group on Tests on Oil and Grease, 1975-present
Co-Chairman, Standard Methods Joint Task Group on Tests on Digestor Gas

Consulting Activities

1. Woodward-Environ, Atlanta, GA - technical consultant on air sampling and analyses (1974-1976)

2. Eco-Science, Inc., Atlanta, GA - technical consultant on chemical analysis of water, wastewater and industrial waste (1975-1976)

3. Fisher Scientific Co., Inc., Atlanta, GA - technical consultant on instrumental methods of chemical analysis, technical consultant on awards for high school science fairs (1974-1976)

4. Paul G. Mayer, Atlanta, GA - technical consultant on potential degradation products of commercially used organic chemicals (1976)

Civic Activities

Member, Tucker High School PTA, 1970-present
Member, Montana State University Alumni Association, 1960-present
Member, South Dakota School of Mines and Technology Alumni Association, 1962-present

Professional and Honor Society

American Chemical Society
The Society of the Sigma Xi
Sigma Pi Sigma
Water Pollution Control Federation
Chairman, 1976 Herty Day Award Selection Committee
Georgia Section - American Chemical Society
Secretary, Georgia Section - American Chemical Society, 1976 -

Name: Joseph P. Gould

Academic Position: Assistant Professor

Education: A.B., Chemistry, Harvard College (1964)
M.S., Water Resources Science, University of Michigan (1967)
PhD., Water Resources Chemistry, University of Michigan (1971)

Professional Societies and Memberships:

American Chemical Society
American Water Works Association
Water Pollution Control Federation
International Ozone Institute
Standard Methods Committee of the American Water Works Association
Research Committee of the Water Pollution Control Federation

Areas of Research Interest

Reactions between chlorine and organic compounds
Ozone in water and waste treatment
Behavior of heavy metals in aqueous solutions
Analysis of organic and inorganic micropollutants
Analytical methods for organic N-chloro compounds
Physical adsorption of compounds from water by active carbon

Publications

Thin Layer Chromatographic Separation of Some C_{19} Steroids, W. G. Dyer, J. P. Gould, et al., Steroids, 1, 271 (1963)

Sorption of Organic Pesticides from Aqueous Solution, W. J. Weber, Jr., J. P. Gould, Advances in Chemistry, 60, 280 (1966)

Oxidation of Phenols by Ozone, J. P. Gould, W. J. Weber, Jr., JWPCF, 48, 47 (1976)

Review of Disinfection, A. W. Hoadley and J. P. Gould, JWPCF, 48, 1166 (1976)

Name: F. Michael Saunders

Academic Position: Assistant Professor of Civil Engineering
Environmental Engineering Program Representative

Education:

B.S.	Civil Engineering	1967	Virginia Polytechnic Inst. and State University
M.S.	Sanitary Engineering	1969	Virginia Polytechnic Inst. and State University
Ph.D.	Environmental Engineering	1975	University of Illinois at Urbana-Champaign

Professional Societies and Memberships

American Society of Civil Engineers
Water Pollution Control Federation, (Research Comm., Student Activities Comm., Standard Methods Comm.)
American Water Works Association
International Association on Water Pollution Research
Association of Environmental Engineering Professors
American Chemical Society
Georgia Water and Pollution Control Association

Courses Taught

CE 4103 Sanitary Engineering I
CE 4113 Sanitary Engineering II
CE 6144 Sanitary Engineering Processes I
CE 6149 Sanitary Engineering Processes II
CE 6113 Industrial Wastewater Treatment
CE 8500 Advanced Sanitary Engineering Seminar

Publications

Saunders, F. M., "Discussion of Design and Operation Model of Activated Sludge by J. H. Sherrard and A. W. Lawrence", Jour. Environmental Engr. Div., ASCE, vol. 100, no. EE6, Proc. Paper 10978, pp. 1289-1290, Dec. 1974.

Kim, B. R., Snoeyink, V. L., and Saunders, F. M., "Influence of CRT on Adsorption", Jour. Environmental Engr. Div., ASCE, vol. 102, no. EE1, Proc. Paper 11937, pp. 55-70, Feb. 1976.

Kim, B. R., Snoeyink, V. L., and Saunders, F. M., "Adsoprtion of Organic Compounds by Synthetic Resins", Jour. Water Poll. Cont. Fed., vol. 48, no. 1, pp. 120-133, January 1976.

Saunders, F. M., and Dick, R. I., "Effect of θ_c on the Extracellular Organic Compounds in Activated Sludge Effluents", Presented at 49th Water Pollution Control Federation Conference, Minneapolis, October 1976.

Contracted Research

"Bioflocculation in the Activated Sludge Process", Environmental Protection Agency
"Nitrification with Attached Films", Department of Interior, Office of Water Research and Technology

Contracted Research continued

"Municipal Wastewater Treatment for Small Communities - Regional Technology Transfer", Department of Interior, Office of Water Research and Technology

"Investigation of Major Water Quality Problems Associated with Wastewater Treatment Systems in Georgia", Georgia Department of Natural Resources, Environmental Protection Division

"Course on Biological Wastewater Treatment Processes", Georgia Department of Natural Resources, Environmental Protection Division

Research Interests

Biological Wastewater Treatment with Suspended and Attached Growth Systems
Nitrification with Attached Films
Effect of Θ_c on Extracellular Organic Compounds in Activated Sludge Suspensions
Effect of Θ_c on Activated Sludge Thickening
Biological Aspects of Adsorption Processes
Membrane Fractionation and Characterization of Organic Contaminants in Wastewater Effluents
Effect of Biological Treatment System on Performance of Tertiary Treatment Processes
Modeling of Attached and Suspended Growth Biological System for Wastewater Treatment
Gravity Thickening of Waste Suspensions

Name: Makram T. Suidan

Academic Position: Assistant Professor of Civil Engineering

Education:

Ph.D.	Environmental Engineering (University of Illinois, 1975)
M.S.	Civil Engineering (University of Illinois, 1973)
B.S.	Civil Engineering (American University of Beirut, 1971)

Professional Societies and Memberships

American Water Works Association
Water Pollution Control Federation
Environmental Science and Technology-ASCE

Courses Taught

CE 4103	Sanitary Engineering I
CE 4113	Sanitary Engineering II
CE 6118	Solid Waste Technology I
CE 6123	Stream Analysis
CE 8113	Physical Principles in Sanitary Engineering

Research Interests

Mathematical Modeling and Reactor Design and Process Control (both Adsorbers and Catalytic)

Optimal Design of Activated Sludge Wastewater Treatment Plants

Removal of Free Chlorine with Activated Carbon

Publications

"Optimum Design of Activated Sludge Wastewater Treatment Plants", Masters Thesis, Department of Civil Engineering, University of Illinois at Urbana-Champaign, Urbana, Illinois (1973).

"Reduction of Aqueous HOCl with Granular Activated Carbon - Batch and Packed Bed Models", with V. L. Snoeyink and R. A. Schmitz, in preparation.

"Reduction of Aqueous Free Chlorine with Granular Activated Carbon - pH and Temperature Effects", with V. L. Snoeyink and R. A. Schmitz, to be presented at the Annual Meeting of the American Institute of Chemical Engineers, Los Angeles, California, November 1975.

"Dechlorination by Activated Carbon", with V. L. Snoeyink, Chapter in Disinfection of Water and Wastewater, J. D. Johnson (ed.), Ann Arbor Science Publishers (1975).

"Modeling and Simulation of Clarification and Thickening Processes", with R. I. Dick, Chapter in Mathematical Modeling of Water Pollution Control Processes, Y. M. Keinath (ed.), Ann Arbor Science Publishers (1975).